NOAA NESDIS

NESDIS Cloud Computing Strategy
NESDIS-PLN-1120.1
Version 1.0

Approval Page

Document Number: **NESDIS-PLN-1120.1**	
Document Title Block: **NESDIS CLOUD COMPUTING STRATEGY**	
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VERSION HISTORY SUMMARY

Version	Description	Revised Sections	Date
1.0	Final, published		Sept 2018

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1. Executive Summary

The National Environmental Satellite, Data and Information Service (NESDIS) has traditionally owned, maintained, and operated the NESDIS Ground Enterprise (NGE) consisting of all of the computing and network infrastructure needed to perform end-to-end ground system functions. The advent of cloud computing enables some or all of these functions to be migrated to shared infrastructure that can be dynamically increased or decreased.

NESDIS' vision is to implement cloud-enabled end-to-end ground service capabilities that are secure, scalable, life-cycle cost effective, and data-source agnostic. This strategic document defines the guiding principles for how NESDIS will leverage cloud computing technology as part of the NGE.

Cloud computing will yield increased efficiency, agility, and innovation in providing end-to-end ground services. A path forward on cloud migration relies upon an enhanced understanding of the architectural and business impacts informed by engineering prototypes and a concept of operations in the cloud. NESDIS will implement cloud computing such that all capabilities will be in compliance with federal security, data and acquisition regulations.

It is anticipated that the cloud migration will provide continuity of NESDIS products and services at a lower overall sustainment and operations cost while simultaneously providing increased agility to develop and deploy capabilities to support multi-mission requirements. NESDIS will pursue cloud computing as a major part of the transformation of the NGE following the guidelines defined within this strategic document. NESDIS will continuously refine and mature its approach and maintain open communications with all NESDIS stakeholders. Active participation and commitment of all NESDIS Offices and Programs is critical to ensure consistency, optimize benefits, and achieve the goals of this strategy.

2. Introduction

The National Environmental Satellite, Data and Information Service (NESDIS) supports NOAA's mission of Science, Service, and Stewardship through satellite missions, environmental information centers, data and information products and services as well as use-inspired science. NESDIS provides reliable and robust services across its enterprise, from systems operations, architecture and data archival systems, to the production of use-inspired science and data applications.

NESDIS has traditionally owned, maintained, and operated NGE consisting of all of the computing and network infrastructure needed to perform the end-to-end ground system functions. The advent of cloud computing enables some or all of these functions to be migrated to shared infrastructure that can be dynamically increased or decreased. NESDIS is therefore actively planning to migrate toward a cloud-enabled NGE to include all IT systems used for data ingest, processing, storage, and dissemination across all NESDIS Offices and Programs.

This does not imply that all NGE capabilities will be migrated to the cloud. While all NGE capabilities will be evaluated for migration, the decision to migrate will be made based on thorough evaluation. While certain capabilities will be targeted for migration, some may be retained on-premises or retired. Transformation of NGE will utilize government and industry best practices to optimize cloud resources and maximize utility.

Migration to the cloud is also mandated by the federal government, which intends to accelerate the pace at which it will realize the value of cloud computing by requiring agencies to evaluate safe, secure cloud computing options before making any new IT investments. NESDIS is committed to cloud computing in alignment with these federal mandates. Specific federal mandates are listed in Appendix B.

The purpose of this strategic document is to define the guiding principles for how NESDIS will leverage cloud computing technology to transform NGE. It will lay out the approach by which targeted NGE capabilities will migrate from on-premises systems to cloud-based services to meet NESDIS business needs.

NESDIS Cloud Vision
NESDIS will implement cloud-enabled end-to-end ground service capabilities that are secure, scalable, life cycle cost effective, and data-source agnostic.

3. What is cloud computing?

NESDIS has adopted the National Institute of Standards and Technology (NIST) definition for cloud computing: a processing and delivery model for enabling adaptive, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Figure 1. Five essential characteristics of cloud computing

This basic cloud model, shown in Figure 1, is composed of five essential characteristics:

1. On-Demand Self-Service - Users are able to provision cloud computing resources without requiring human interaction.
2. Broad Network Access - Cloud computing resources are accessible over the network, supporting heterogeneous client platforms such as mobile devices and workstations.
3. Resource Pooling - Platform may service multiple customers from the same physical resources by securely separating the resources on logical level.
4. Rapid Elasticity - Resources are provisioned and released on-demand, making sure that an application will have exactly the capacity it needs at any point of time.
5. Measured Service - Resource usage is monitored, measured, and reported (billed) transparently based on utilization (pay-per-use).

4. Benefits of Migrating to the Cloud

Transformation of NGE will evolve current ground systems development and sustainment practices away from systems-based mission stovepipes towards shared multi-mission services.

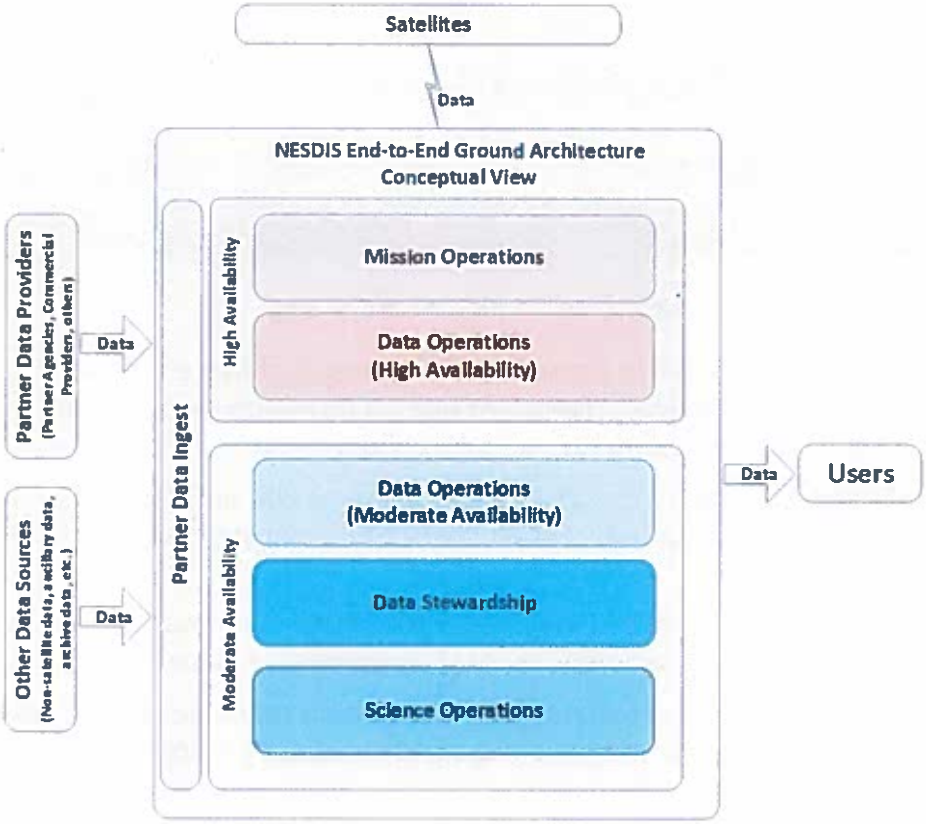

Figure 2. NESDIS End-to-End Ground Architecture

Figure 2 shows a notional NGE architecture, which details the strategic view of NESDIS' business services: Mission Operations, Data Operations, Data Stewardship, and Science Operations. Input data come from NOAA operated satellites, Partner Data Providers, and other observing systems. Output data to the users include near-real-time and retrospective data, products, and services. Typical users of NESDIS data are NOAA line offices including NESDIS, domestic and international partner agencies, researchers, academia, and the public.

The goals of this future architecture are to provide continuity of products and services at expected performance thresholds with the flexibility to accommodate exponentially increasing data volumes as well as new data types in a cloud-enabled environment. This will support evolution from mission-specific systems toward multi-mission services and enable the development of new products and services using NESDIS data. In order to make the migration as transparent as possible to the users, it will be performed by

maintaining the existing interfaces unless the users are also migrating to the cloud. Additional details will be provided in forthcoming documents.

Migrating to a cloud-based environment provides the following three key benefits:

1. Efficiency - Most on-premises data centers have an excess storage and processing capacity due to the inherent difficulties in capacity planning. Mission critical systems also require excess reserve compute and memory capacity. The cloud optimizes the IT footprint by providing cloud services that scale with demand. This improves asset utilization and productivity. Use of cloud computing also improves business practices.
2. Agility - The cloud significantly improves business agility by provisioning services and capacity quickly. This near-instantaneous elasticity (within minutes) to increase the computing resources as opposed to weeks or months for similar increase in case of on-premises systems enables NESDIS to become more flexible and responsive to user needs.
3. Innovation - The cloud enables research and development of new and innovative services without big upfront investments in data center upgrades. Significantly, it changes the traditional data access paradigm, providing opportunities to streamline data access, processing, and dissemination. Improved data availability and ease of use will improve overall product quality.

5. Strategic Goals

To help illuminate a path to transform NGE, NESDIS has defined the following goals for cloud computing adoption and use. Though it is too early to prescribe exact guidance for the use of cloud computing, NESDIS, through this document, is able to provide prudent boundaries of behavior or value applicable to cloud computing that will help support decision-making when NESDIS embarks upon cloud migration.

Continuity of operations, products, and services provided has been, and will continue to be, the foundation of the NESDIS mission. NESDIS will align with and uphold this principle while implementing cloud functionality.

1. NESDIS will evaluate the benefits of migrating targeted NGE capabilities to the cloud using trade studies, cost-benefit analysis, and enterprise risk assessment.
2. NESDIS will maximize use of cloud-native capabilities to enhance the enterprise capabilities of NESDIS.
3. NESDIS will implement clear governance by defining roles and responsibilities both internal to the organization and within the cloud.
4. NESDIS will define requirements for the cloud architecture to include confidentiality, integrity, and availability drivers for IT and business processes.
5. NESDIS will leverage government and industry best practices to optimize cloud resources and maximize utility.
6. NESDIS will remain in compliance with security, data, and acquisition regulations as targeted NGE capabilities are migrated to the cloud.
7. NESDIS will collaborate with NOAA OCIO and Line Offices and other cloud initiatives, such as the NOAA Big Data project, to maximize the benefits of cloud adoption.

6. A Fundamental Change to How NESDIS Does Business

While the adoption of cloud computing offers multiple potential benefits to NESDIS, it also presents critical challenges that must be considered when evaluating and deciding to use cloud computing. NESDIS will do a thorough analysis of these challenges before implementation in the cloud. These challenges can also be seen as opportunities to modernize and streamline the NESDIS ground architecture as well as its business practices. Government and industry best practices, as well as collaboration with other federal agencies, will be leveraged to develop efficient and effective plans for cloud adoption.

Successful migration to the cloud must take into account the following six key areas of NESDIS impacted by cloud adoption, assess the migration readiness of these key areas, and ultimately create a coordinated migration plan. For each of the key areas, NESDIS will establish a cross-organization IPT to create an action plan mapping required staff skills and organizational processes against available skills and processes, and develop a plan to address the gaps. This occurs in four steps:

1. Identify the stakeholders critical to cloud adoption.
2. Understand the questions and concerns that may delay or impede cloud adoption for those stakeholders.
3. Identify skills or processes that must be updated to address those questions and concerns.
4. Create an action plan for updating the identified skills and/or processes.

The six key areas are:

1. **Business** - This key area helps NESDIS move from separate strategies for business and IT to a business model that integrates IT strategy. IT strategies are aligned to support NESDIS business outcomes. Typical roles include project and program managers, finance managers, management and program analysts, budget owners, and other stakeholders.
2. **People** - This key area helps Human Resources (HR) and personnel management prepare their teams for cloud adoption by updating staff skills and organizational processes. Cultural changes must be considered in addition to cloud-related competency. Typical roles include human resources, staffing, and people managers.
3. **Governance** - This key area integrates IT Governance and Organizational Governance. It provides guidance on identifying and implementing best practices for IT Governance and on supporting business processes with technology. Typical roles include Chief Information Officer (CIO), program managers, project managers, enterprise architects, and business analysts.

4. **Platform** - This key area helps NESDIS design, implement, and optimize the architecture of cloud technology based on business goals and objectives. It helps provide strategic guidance for the design, principles, tools, and policies NESDIS will use to define cloud services. It also includes principles and patterns for communicating the target state environment, implementing new solutions on the cloud, and migrating on-premises workloads to the cloud. Typical roles include Chief Technology Officer, IT Managers, and solution architects.
5. **Policy** - This key area helps NESDIS structure the selection and implementation of NESDIS policy, compliance, and security controls. Following this guidance can ease identifying areas of non-compliance and plan ongoing security initiatives. Typical roles include Chief Information Security Officer (CISO), IT Security Managers, and IT Security Analysts.
6. **IT Operations** - This key area helps NESDIS to operate and manage NGE to meet the requirements of NESDIS stakeholders. Insights gained help define NESDIS' current operating procedures as well as process changes and training needed for successful cloud adoption. Typical roles include IT Operations Managers, IT Support Managers, and IT Specialists.

7. Path Forward with Cloud Computing

Success of cloud migration initiatives comprises more than just an efficient utilization of cloud technology and the right deployment approach. Changes must happen in the following stages as the ability of NESDIS to leverage cloud matures:

1. **Experimentation** - Currently, NESDIS has limited knowledge of cloud services and will increase understanding directly through demonstration projects, training, and leadership support. NESDIS will support architectural experiments, pilot studies, and training that span the breadth of the NGE. NESDIS plans to collaborate with other federal agencies, using lessons learned and recommendations on cloud implementation based on their experiences to accelerate experimentation. Specifically, NESDIS will explore collaboration with NASA, as NASA Earth Sciences is aggressively moving to the cloud. As a result of experimentation, NESDIS' workforce, from senior and mid-level managers to individual contributors, will then gain experience functioning within the cloud environment. During this stage, NESDIS will provide centralized management of all cloud pilots and prototype development activities. NESDIS will establish guidelines for readiness assessment of ground services to the cloud. NESDIS will also develop a Concept of Operations (ConOps) to guide the end-to-end systems engineering of the ground services in a cloud-enabled environment.
2. **Migration** - NESDIS will mature its cloud-enabled governance, technical, and operational business practices to effectively and efficiently migrate targeted elements to the cloud. NESDIS will conduct a portfolio assessment of readiness to migrate end-to-end ground services using the knowledge gained in the experimentation stage. This assessment will be aligned with critical NESDIS mission milestones to minimize disruption in continuity of operations or introduce uncertainties/risks in mission implementations.. NESDIS will then develop a migration strategy that defines a clear path from the current environment to the target environment, determine a migration process, and execute the migration of all targeted NGE capabilities to the cloud. NESDIS anticipates that it will begin to realize the benefits of the cloud environment immediately following the migration and realize further benefits through downstream cost and service optimization.
3. **Optimization** - NESDIS will utilize continuous improvement processes to optimize the NGE capabilities in the cloud. New cloud services can then be implemented to augment or replace existing services to add value. The lifecycle of ground services in the cloud environment will be streamlined and business practices will be optimized through continuous improvement in a cost-effective manner. In this way, NESDIS can accurately quantify and manage use of cloud computing resources and subsequently develop the most cost-efficient utilization methodology.

Figure 3. NESDIS Notional Migration Diagram

Migrating to the cloud is an iterative process that evolves as NESDIS develops new skills, processes, tools, and capabilities. NESDIS will therefore continuously seek to refine and mature the cloud computing approach. Establishing the right foundation is key to a successful migration, as initial migrations help build experience and depth of knowledge that will accelerate later migration efforts. The migration process should balance the business and technical efforts needed to complete a cloud migration.

Successful migration to the cloud also requires clear and continuous communications with key stakeholders. NESDIS will establish a robust communications plan to keep key stakeholders engaged in the cloud migration efforts. Active participation and commitment of all NESDIS Offices and Programs is critical to ensure a consistent and optimized cloud migration.

8. Conclusion

NESDIS' vision is to implement cloud-enabled end-to-end ground service capabilities that are secure, scalable, life-cycle cost effective, and data-source agnostic. NESDIS will pursue cloud computing as a major part of the transformation of the NGE following the guidelines defined within this strategic document. NESDIS expects cloud migration to provide continuity of NESDIS products and services at a lower overall sustainment and operations costs while simultaneously providing increased agility to develop and deploy capabilities to support multi-mission requirements.

Cloud computing brings a fundamental change to how NESDIS conducts its business. Therefore, for each key area of business impacted by cloud adoption, NESDIS will assess the migration readiness and create a migration plan to address gaps in staff skills and organizational processes. NESDIS acknowledges that migrating to the cloud is an iterative process that evolves as NESDIS develops new skills, processes, tools, and capabilities. Therefore, NESDIS will continuously seek to refine and mature the cloud computing approach and maintain open communications with all NESDIS stakeholders. Active participation and commitment of all NESDIS Offices and Programs is critical to ensure consistency, optimize benefits, and achieve a successful cloud migration.

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LIST OF ACRONYMS

ConOps	Concept of Operations
FedRAMP	Federal Risk and Authorization Management Program
IaaS	Infrastructure as a Service
IGE	Integrated Ground Enterprise
IPT	Integrated project Team
IT	Information Technology
NIST	National Institute of Standards and Technology
OMB	Office of Management and Budget
PaaS	Platform as a Service
R2O	Research-to-Operations
SaaS	Software as a Service
HBK	Handbook
JPEG	Joint Photographic Experts Group
NESDIS	National Environmental Satellite, Data, and Information Service
NOAA	National Oceanic and Atmospheric Administration
OCR	Optical Character Recognition
PDF	Portable Document Format
QMS	Quality Management System
STAR	Center for Satellite Applications and Research
STC	Society for Technical Communication

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